

and second catalysts are coated on an alumina substrate.

- [c7] 7. The catalyst system of claim 6, wherein said alumina substrate in said first zone is stabilized by between 1–8% (wt) La_2O_3 .
- [c8] 8. The catalyst system of claim 6, wherein said alumina substrate in said second catalyst is stabilized by 2–15% (wt) BaO.
- [c9] 9. The catalyst system of claim 1, wherein said first zone of said first catalyst further comprises a metal oxide selected from the group consisting of barium oxide, magnesium oxide, potassium oxide and combinations thereof, wherein the metal oxide comprises 2–15% (wt).
- [c10] 10. The catalyst system of claim 1, wherein said second zone of said first catalyst further comprises a metal oxide selected from the group consisting of barium oxide, magnesium oxide and combinations thereof.
- [c11] 11. The catalyst system of claim 10, wherein said second zone of said first catalyst comprises BaO and MgO of 10–40% (wt).
- [c12] 12. The catalyst system of claim 1, wherein said catalyst mixture PM–Rh in said first zone of said first catalyst comprises Pt and Rh in a ratio of between 5:1 and 25:1.
- [c13] 13. The catalyst system of claim 1, wherein said catalyst mixture PM–Rh in said first zone of said first catalyst has a loading of between 60–300 g/ft³.
- [c14] 14. The catalyst system of claim 1, wherein said second zone of said first catalyst comprises Pt and Rh in a ratio of between 1:1 and 10:1.
- [c15] 15. The catalyst system of claim 1, wherein said catalyst mixture PM–Rh in said second zone of said first catalyst has a loading of between 10–100 g/ft³.
- [c16] 16. The catalyst system of claim 1, wherein said catalyst mixture PM–Rh in said second catalyst comprises Pt and Rh in a ratio of between 5:1 and 15:1.
- [c17] 17. The catalyst system of claim 1, wherein said catalyst mixture PM–Rh in said second catalyst has a loading of between 10–120 g/ft³.

- $$\frac{d_1}{\pi} \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} = \frac{1}{\pi} \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$$

- [c23] 23. The catalyst system of claim 21, wherein said catalyst mixture PM-Rh in said top layer of said first catalyst has a loading of between 60–300 g/ft³.
- [c24] 24. The catalyst system of claim 21, wherein said catalyst mixture PM-Rh in said top layer of said first catalyst comprises Pt-Rh stabilized by 2–15 wt% of BaO.
- [c25] 25. The catalyst system of claim 21, wherein said Rh in said second bottom layer of said first catalyst is placed on ZrO₂ particles of 3–5% (wt) and BaO and MgO particles of 2–30% (wt).
- [c26] 26. The catalyst system of claim 21, wherein said catalyst mixtures of said first and second catalysts are coated on an alumina substrate.
- [c27] 27. The catalyst system of claim 26, wherein said alumina substrate in said bottom layer of said first catalyst is stabilized by between 2–8% (wt) La₂O₃.
- [c28] 28. The catalyst system of claim 26, wherein said alumina substrate in said bottom layer of said first catalyst is stabilized by composite oxides of cerium–lanthanum.
- [c29] 29. The catalyst system of claim 21, wherein said catalyst mixture PM-Rh in said second catalyst comprises Pt and Rh in a ratio of between 5:1 and 15:1 with a total loading of between 10–120 g/ft³.
- [c30] 30. The catalyst system of claim 21, wherein PM-Rh in said second catalyst comprises Pt and Rh placed on Ce and Zr particles of 5–30 wt%, wherein the molar ratio of Ce and Zr is 50:50.
- [c31] 31. A catalyst for use with an internal combustion engine to provide emission reductions, comprising:
a first and a second zone;
said first zone comprising a) a catalyst mixture PM-Rh where PM is a catalyst material selected from the group consisting of Pt, Pd and combinations thereof, and b) a metal oxide selected from the group consisting of cerium, zirconium and combinations thereof; and
said second zone comprising a) a catalyst mixture PM-Rh, where PM is a catalyst material selected from the group consisting of Pt, Pd and combinations thereof;

- [c24] 24. The catalyst system of claim 21, wherein said catalyst mixture PM-Rh in said top layer of said first catalyst comprises Pt-Rh stabilized by 2-15 wt% of BaO.

- [c25] 25. The catalyst system of claim 21, wherein said Rh in said second bottom layer of said first catalyst is placed on ZrO_2 particles of 3–5% (wt) and BaO and MgO particles of 2–30% (wt).

- [c26] 26. The catalyst system of claim 21, wherein said catalyst mixtures of said first and second catalysts are coated on an alumina substrate.

- [c27]. 27. The catalyst system of claim 26, wherein said alumina substrate in said bottom layer of said first catalyst is stabilized by between 2–8% (wt) La_2O_3 .

- [c28] 28. The catalyst system of claim 26, wherein said alumina substrate in said bottom layer of said first catalyst is stabilized by composite oxides of cerium-lanthanum.

- [c29] 29. The catalyst system of claim 21, wherein said catalyst mixture PM-Rh in said second catalyst comprises Pt and Rh in a ratio of between 5:1 and 15:1 with a total loading of between 10–120 g/ft³.

- [c30] 30. The catalyst system of claim 21, wherein PM-Rh in said second catalyst comprises Pt and Rh placed on Ce and Zr particles of 5–30 wt%, wherein the molar ratio of Ce and Zr is 50:50.

- [c31] 31. A catalyst for use with an internal combustion engine to provide emission reductions, comprising:
- a first and a second zone;
- said first zone comprising a) a catalyst mixture PM-Rh where PM is a catalyst material selected from the group consisting of Pt, Pd and combinations thereof, and b) a metal oxide selected from the group consisting of cerium, zirconium and combinations thereof; and
- said second zone comprising a) a catalyst mixture PM-Rh, where PM is a catalyst material selected from the group consisting of Pt, Pd and combinations thereof;

and b) a metal selected from the group consisting of oxides of aluminum, alkali metals, alkaline earth metals and combinations thereof, wherein said second zone is devoid of cerium.

- [c32] 32. A catalyst for use with an internal combustion engine to provide emission reductions, comprising:
- a first, second and third zone, said first zone comprising a) a catalyst mixture PM-Rh where PM is a catalyst mixture selected from the group consisting of Pt, Pd and combinations thereof, and b) a metal oxide selected from the group consisting of cerium, zirconium and combinations thereof;
- said second zone comprising a) a catalyst mixture Pm-Rh, where PM is a catalyst material selected from the group consisting of Pt, Pd and combination thereof; and b) a metal selected from the group consisting of oxides of aluminum, alkali metals, alkaline earth metals and combinations thereof, wherein said second zone is devoid of cerium; and
- said third zone comprising a) a hydrogen sulfide suppressant, b) a catalyst mixture PM-Rh where PM is a catalyst material selected from the group consisting of Pt, Pd and combinations thereof, and c) a metal oxide selected from the group consisting of cerium, zirconium and combinations thereof.